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ABSTRACT

This study examined the mathematics achievement of elementary school students to determine whether a district-developed National Council of Teachers of Mathematics (NCTM) standards-based mathematics curriculum taught by trained teachers was more or less effective than the traditional curriculum that was being used. A nonrandom group of 13 teachers who had been trained in the new curriculum taught it to their students. The kindergarten was eliminated because norm-referenced tests were not given at that level, leaving 10 teachers and their classes. The control consisted of 24 teachers and classes using the curriculum already in place. Pretests and posttests using the Iowa Tests of Basic Skills were administered to students in both groups. There was a significant difference between the experimental and control groups, with students in the experimental group scoring more highly than those in the control group. There were no significant differences between male and female students. (Contains 4 tables and 22 references.) (SLD)

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An Evaluation of a District-Developed NCTM Standards-Based Elementary School Mathematics Curriculum

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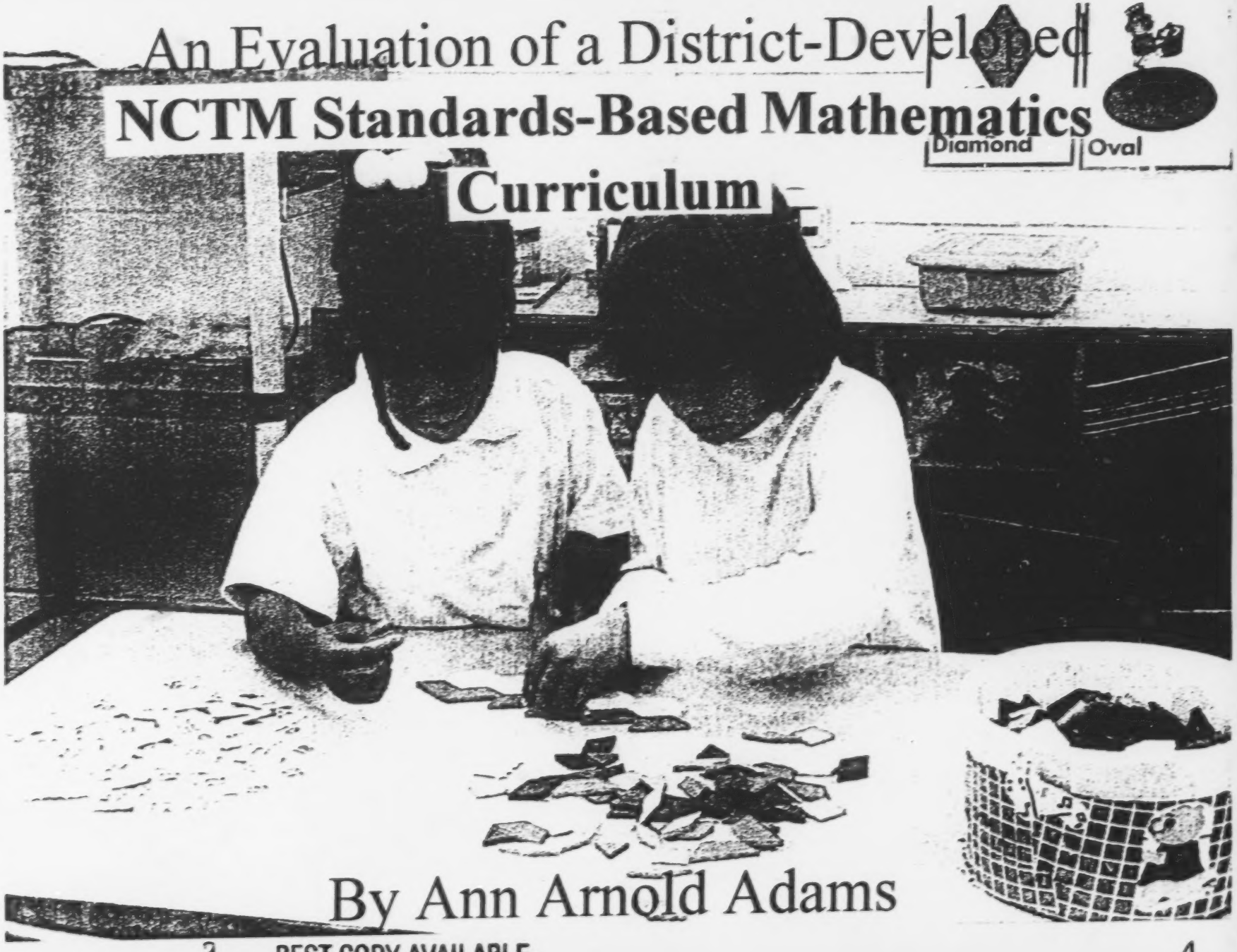

By Ann Arnold Adams

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Abstract:

This study examined the mathematics achievement of elementary school students to determine whether a district-developed NCTM Standards-based mathematics curriculum taught by trained teachers was more or less effective than the traditional curriculum that was currently being used.

A non-random group of 13 teachers who had been trained in using the new Standards-based curriculum taught the new curriculum to their students. After eliminating kindergarten because norm-referenced tests were not administered at that level, there were 10 experimental teachers and classes remaining in the study. The control group was comprised of other teachers in the school district who taught at the same grade levels as the experimental teachers. Therefore, the control group of 24 teachers and their classes was larger than the experimental group. Teachers in the control group continued to use the curriculum that was already in place. Pretests and posttests, using the Iowa Tests of Basic Skills for mathematics, were administered to students in both groups. The tests were administered following the standardized, highly secure procedures developed and regulated by the Mississippi Department of Education. Individual scores were analyzed, using an analysis of covariance. Pretest NCE's were the covariate, and posttest NCE's were the dependent variable. Both sex of students and group type were considered. An outside evaluator, PREPS (Program for Research and Evaluation in Public Schools) of Mississippi State University, was used.

There was a significant difference between the experimental and control groups, $p > .001$. There was no significant difference between male and female students, $p = .843$. There was no significant interaction of group by sex, $p = .301$. The conclusion of the study was that students in the experimental group, taught by trained teachers, scored higher in mathematics NCE's than students in the control group, whose teachers did not use the new curriculum and had not been trained in using it.

An Evaluation of a District-Developed NCTM Standards-Based Mathematics Curriculum

Ann Arnold Adams

Under a three-year FIRST: Schools and Teachers Program (Fund for Improvement and Reform of Schools and Teachers) grant from the U. S. Department of Education, the Leflore County School District developed a curriculum for teaching mathematics. The curriculum was designed to be aligned with the National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics* (1989) and *Professional Standards for Teaching Mathematics* (1991), both hereafter referred to as the NCTM Standards or the Standards. (NCTM published the separate evaluation recommendations, *Assessment Standards for School Mathematics* (1995), during the district's evaluation of its newly developed curriculum.) Consultants from Mississippi Valley State University, Delta State University, Mississippi College, and the Mississippi Department of Education assisted with the development of the curriculum.

Committees of teachers studied the NCTM Standards and developed a district math curriculum that was aligned with the standards. The curriculum was designed to accomplish the NCTM five overall curricular goals: learning to value mathematics, becoming confident in one's own ability, becoming a mathematical problem solver, learning to communicate mathematically, and learning to reason mathematically. The curriculum consisted of objectives, processes, and evaluation components. The objectives were horizontally and vertically sequenced in strands. The processes (the instructional activities and procedures teachers and students would use to facilitate the students' achievement of the objectives) emphasized hands-on use of manipulatives, cooperative learning groups, problem solving, and connections to the real world. The evaluation components included sample tests, scoring criteria, strategies, and observational criteria. The curriculum and processes were field tested during the development phase of the program.

In order to prepare teachers for developing curriculum, professional development was provided. A graduate mathematics course was developed especially for the district. During two consecutive school years, this free course was made available to all district teachers and administrators. Resource materials and mathematics training for teachers were provided.

Mississippi is a state with a high-stakes testing program. School districts' accreditation ratings are very heavily based on test scores. The Iowa Test of Basic Skills (ITBS) was used by the state for a majority of the outcome measures that were used to determine accreditation ratings for districts. Therefore, before fully implementing the new mathematics curriculum, it was important to the district to determine which curriculum-- the Standards-based curriculum or the traditional curriculum already in place in the district--resulted in superior scores on the ITBS.. A study was conducted to compare the ITBS scores attained by students using the NCTM Standards-based curriculum with the scores of students using the traditional curriculum. The traditional curriculum was defined as the curriculum that was currently in place in the district. The traditional curriculum included a heavy emphasis on basic skills and the use of the textbook.

Problem Development

There has been a strong effort at the national and state levels to encourage the incorporation of the Standards into schools and classrooms. Federal and state grant programs often include the requirement that instruction be Standards-based. There is a large body of literature comprised of recommendations to follow the NCTM Standards, explanations of the Standards, and/or suggestions of how to implement Standards-based instruction. Actual research in the effectiveness of Standards-based mathematics education comprises a much smaller body of literature.

Goldsmith and Mark (1999) describe standards-based mathematics instruction as emphasizing the development of conceptual understanding and reasoning, active involvement of students, students' working collaboratively, and the use of hands-on activities. Burns (1993, 1996) strongly advocates the use of manipulative materials for teaching math at all grade levels. Crawford and Witte (1999) describe five attributes they find to be common to classrooms in which students are actively engaged in constructing their own knowledge and understandings: relating, experiencing, applying, cooperating, and transferring. Simon (1986), describes the role of the teacher in using Standards-based approaches to developing mathematical concepts.

Futch and Stephens (1997) found that a group of Georgia middle school math teachers and administrators agreed with almost 70 percent of the Standards but that many did not accept 31% of the beliefs underlying the Standards, even though Georgia had made a special effort to encourage the use of the Standards. Sherman and Richardson (1995) found a lack of uniformity in teachers' beliefs concerning the use of manipulatives. "If teachers do not believe in the effectiveness of a particular methodology for teaching mathematics, they are much less likely to use it. (Bauch, 1984)

Suydam (1985) describes the use of manipulative instructional materials prior to the publishing of the Standards. She summarizes research indicating that the most widely used instructional material is the textbook. Suydam reports that most teachers use materials other than the text fewer than six times a year. Mokros (1994) reports that textbooks are not aligned with the Standards.

It is easier to advocate the Standards than it is to implement them (Lowenberg Ball and Schroeder (1992). Hatfield (1994) examines the use of manipulatives for math instruction by teachers who supervise and train student teachers. Her study examined the degree to which teachers reported that they used certain identified manipulatives. This survey revealed that although most supervising teachers claimed to be familiar with and had access to manipulatives, devices were seldom used and there was a pattern of decreasing use of manipulatives as the grade levels increased from kindergarten to sixth. Ernest (1994) found that professional development with follow-up resulted in increased use of manipulatives by secondary teachers.

Garrity (1998) found that test scores of students using manipulatives improved when students

worked together with other students but did not improve when students worked alone. Chester, J. (1991) reported that geometry students using manipulatives had significantly higher test scores than those not using manipulatives. Ginsburg-Block and Fantuzzo (1998) report that students receiving Standards-based instruction in computation and word problems and who worked together with other students were more successful than those who did not.

Notwithstanding the national and state encouragement to align curricula with the Standards, there are those who allege that the Standards are not grounded in adequate research, that insufficient attention is given to some important mathematical skills and procedures, and that overemphasis is placed on some nonessential content. (Cook, 1995)

Herrera and Ozgün-Koca (1999) identify seven Standards-based practices that have shown promise. Promise, but ten years after the Standards were published, there are still no answers (Hiebert, 1999).

Research of Standards-based curricula is needed to determine whether or not instruction aligned with the Standards will result in increased mathematics achievement for students. More convincing research results will increase educators' confidence as they decide whether and/or how to align curriculum and instruction with the Standards. (Hiebert, 1999).

Procedure

Thirteen district teachers taught the NCTM Standards-based curriculum during the 1994-1995 school year. The students of these teachers were considered to be the experimental group. Because the district did not administer standardized tests to kindergarten students, three kindergarten classes were removed from the experimental group. The remaining experimental classes were in grades 1-7.

The control group included twenty-nine classes of 1st - 7th grade students taught the traditional curriculum by twenty-four teachers.

The number of control students was greater than the number of experimental students. This was due to the manner of selecting control teachers. For each grade level, 1st -7th , a school with no experimental teachers at that grade level was selected at random as the control. All the students at that grade level in the control school were identified as control group students.

Students of the experimental teachers were pooled to form the experimental group of students, and students of the control teachers were pooled to form the control group of students. Individual ITBS mathematics pretest and posttest scores were attained for 220 experimental students and 454 control students.

Limitations of the study included that the teachers of the experimental groups were non-random volunteers and that the numbers of students in the experimental and control groups were uneven.

These limitations affect the generalization of results.

A strength of the study was that an outside evaluator, PREPS (Program for Research and Evaluation of Public Schools) of Mississippi State University, conducted the analysis of the data.

PREPS took the data from the ITBS tabulation sheets of each experimental and control class included in the study. Each student was assigned a number that included school, grade, teacher, personal number, age, sex, math NCE (Normal Curve Equivalent), math NPR (National Percentile Rank), core battery total NCE and core battery total NPR. Because of absences, some students did not have both pretest and posttest scores.

An Analysis of Covariance (ANCOVA) was used to analyze the data. There were 673 total degrees of freedom. The effects examined were a comparison of the two groups (experimental and control) and a comparison by sex (female or male).

Frequencies of Variables

Table 1

Cell Means and Count for Group		
	Experimental	Control
Mean	47.11	40.52
Count	220.00	454.00

PREPS

Table 2

Cell Means and Count for Sex		
	Female	Male
Mean	42.55	42.79
Count	339.00	335.00

PREPS

Table 3

Cell Means and Count for Group by Sex			
	Female	Male	Total/Average
Experimental	45.76	48.70	40.94
Count	119	101	220
Control	40.82	40.24	40.53
Count	220	234	454

PREPS

Results

The covariates were the NCE's of the math pretests, and the dependent variables were the NCE's of the math posttests. The ANCOVA revealed a significant difference between the experimental and control groups, F (1,669) = 24.49, p = .001. The experimental group (M = 47.11) scored higher than the control group (M = 40.52). There was no significant difference between female and male students, F (1,669) = .039, p = .843. Nor was there a significant interaction between the groups by sex, F (1,669) = 1.073, p = .301.

Summary Table

Source of Variation	SS	DF	MS	F	SigF
PreMNCE *(Covariate)*	77933.11	1	77933.11	N/A	N/A
Main Effect *(Group)*	5605.44	1	5605.44	24.49	**.001***
Main Effect *(Sex)*	8.95	1	8.95	.04	.843
Interaction *(Group x Sex)*	245.64	1	245.64	1.07	.301
Explained	83793.12	4	20948.28	------	------
Residual	153151.756	669	228.93	------	------
Total	236944.88	673	352.07		

PREPS

Conclusions

The experimental group of students who used the district-developed Standards-based curriculum throughout the school year had significantly ($p \leq .001$) higher ITBS scores than the control group

of students whose teachers continued to use the district's traditional curriculum. The Standards-based curriculum did not prove to be significantly more effective for one sex than for another. Nor was there an interaction between group and sex.

The results of this study encouraged the school district to proceed to implement the new Standards-based curriculum beyond the original group of experimental classes.

The Standards-based curriculum included the use of manipulatives, students working collaboratively, hands-on active learning, and mathematical concepts not taught in the traditional curriculum. It was designed around the NCTM overall curricular goals for students to achieve. However, no documentation was collected and analyzed on such issues as how often manipulatives were used or how frequently students constructed their own knowledge. Therefore, no conclusions may be drawn as to which of the differences in the Standards-based curriculum had the greatest impact or even if there were some differences that had a negative outcome.

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